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Small-Scale Wind Structure above 100 Kilometers

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Hines [1960] has estimated the minimum scale size of atmospheric gravity waves by considering the variations from the mean of the wind velocity magnitude that are observed in visible meteor trails at altitudes between 80 and 100 km. To get these estimates he superposes a constant shear upon the measured meteor-trail wind velocity and then measures the altitude between the sequential points where the magnitude of this normalized wind velocity goes to zero. By this method he has subtracted the effect of the mean wind shear from the observed path of the visible trail which leaves atmospheric perturbations, such as gravity waves, to cause deformation of the trail.

This technique is valid only over the altitude range where the mean wind shear is constant. Any altitude variation of the mean wind velocity from a linear function will then introduce errors in the measurement of scale sizes. However, by measuring directly the altitude increment between inflection points of the magnitude of the wind velocity, as deduced from photographs of the trail deformation, the wavelengths or scale sizes of these small-scale perturbations may be determined without the possible error introduced by the superposition of a correcting mean shear field. This technique is valid only if the wavelength of the mean wind velocity is large compared with the wavelength of the small-scale velocity perturbations. Thus the effect of the altitude variation of the mean wind will be to perturb slightly the measurement of the distances between small-scale inflection points. It is instantly recognizable that if the mean wind velocity has a linear altitude dependence, this technique will yield the same results as Hines'.

This type of analysis was applied to sodium trail releases that covered the altitude range of 80 to 160 km. The experiments were performed at Wallops Island, Virginia, by *Manring* [1962] and others, at Eglin AFB, Florida, by *Rosenberg et al.* [1963], and at Woomera, Australia, by G. V. Groves (private communication, 1960). The data were separated into summer and winter components as shown in Figures 1 and 2. Superposed on these are the viscous small-scale limitation hypothesized by Hines and the pressure scale height from the 1959 ARDC Model Atmosphere [*Minzner et al.*, 1959], as another scale length of interest. From 100 to 125 km, Hines' small-scale limit indeed shows a relationship to the measured value of these minor nodes; however, at about 130 km, for the summer data, there appears to be an abrupt transition of the nodal sizes from Hines' limit to a

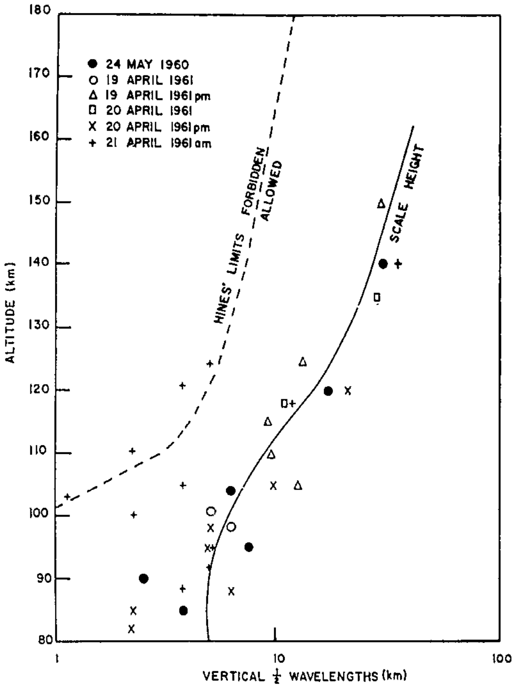

Fig. 1. Summer measurements of vertical half-wavelengths. The data are from *NASA Report NAS5-215*.

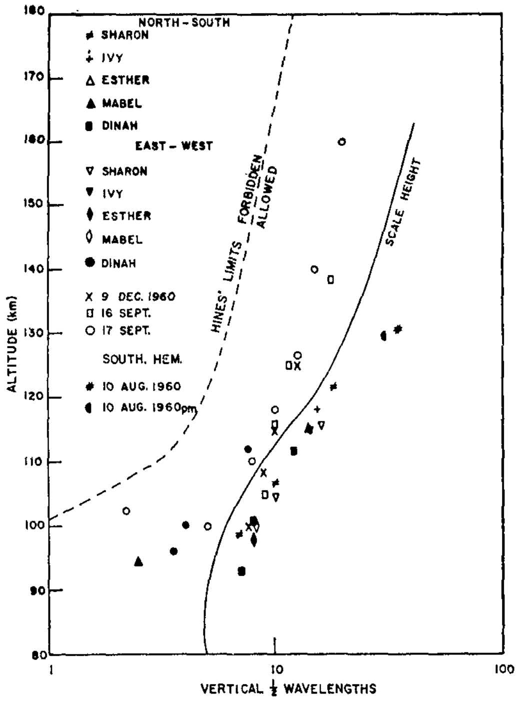

Fig. 2. Winter measurements of vertical half-wavelengths. The data labeled with names are those of Rosenberg et al., December 1962, the data dated December and September are from *NASA Report NAS5-215*, and the August 1960 data points are from Groves at Woomera, Australia. The superposed curves are the same as in Figure 1.

value proportional to the atmospheric pressure scale height. Since the 1959 ARDC atmosphere was compiled for a summer day, a possible connection between the parameters of scale height and the altitude variations of the wind velocity above 140 km is apparent.

These conclusions are obviously rough and highly debatable. However, the empirical fit to data gives some credence to them. It is also obvious that many more experiments of this nature must be performed, to gather more statistical evidence, before any definite conclusion can be reached.

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